DOCUMENT RESUME

ED 437 121 JC 980 311

AUTHOR	Box, Lynda L.
TITLE	Retention Strategies for Women in the Physical Sciences at Bergen Community College.
INSTITUTION	Princeton Univ., NJ. Mid-Career Fellowship Program.
PUB DATE	1998-00-00
NOTE	16p.; In its: "Issues of Education at Community Colleges: Essays by Fellows in the Mid-Career Fellowship Program at Princeton University"; see JC 980 309.
PUB TYPE	Reports - Descriptive (141)
EDRS PRICE	MF01/PC01 Plus Postage.
DESCRIPTORS	Academic Achievement; Careers; Community Colleges; Curriculum Development; Employed Women; Females; Majors (Students); Mentors; *Physical Sciences; *School Holding Power; *Sex Bias; Sex Differences; *Sex Discrimination; Sex Stereotypes; Teaching Methods; Tutoring; Two Year Colleges; Women Faculty; *Womens Education
IDENTIFIERS	*Bergen Community College NJ

ABSTRACT

This document discusses the representation and retention of women in science. Though women make up 48% of the employed labor force in the United States, they constitute only 22% of all working scientists and engineers. And though women scientists and engineers are beginning to find more employment in academia, they are more likely to teach only part-time in two-year schools, with less PhD's and less chance at holding higher-ranked positions at educational institutions. In order to counter the extreme under-representation of women in the physical sciences at Bergen Community College, this paper proposes a curriculum that acknowledges the contributions of all scientists, male and female. It further discusses different teaching styles and ways to create an environment that encourages women to actively participate. The paper also presents women's contributions in science. Methods of mentoring and tutoring to foster self confidence and academic success; and ways to encourage women to enter the sciences and to request financial aid. (YKH)

Reproductions supplied by EDRS are the best that can be made
from the original document.

ED 437 121

RETENTION STRATEGIES FOR WOMEN IN THE PHYSICAL SCIENCES AT BERGEN COMMUNITY COLLEGE

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)
This document has been reproduced as received from the person or organization originating it.
Minor changes have been made to improve reproduction quality.
Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

PERMISSION TO REPRODUCE AND DISSEMINATE THIS MATERIAL HAS BEEN GRANTED BY
T. Rabb
TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

In: Issues of Education at Community Colleges
Essays by Fellows in the Mid-Career Fellowship Program at Princeton Univ.

SUBMITTED BY
DR. LYNDA L. BOX
PRINCETON MID-CAREER FELLOWSHIP PROGRAM
1998

TC 980 311

BEST COPY AVAILABLE

CONTENTS

	page
Foreword	2
Representation of Women in Science	3
The Rationale for Including Women in Science	5
Some Obstacles Facing Women in Science	6
Science at Bergen Community College	7
Retention Strategies for Women in Science at Bergen Community College	11
Bibliography	14

FOREWORD

Even though women make up the majority of the population in the United States, and are entering the workforce in greater numbers, their representation in the science and engineering workplace still remains small.

Women have traditionally been excluded from science, especially at the policy making levels, so that the science that is now taught, the way it is practised, and the way that it is allowed to progress, has been determined by men.

Women entering the science field face challenges in landing prestigious jobs with the same salaries as men, and in obtaining promotions and important projects. Feelings of isolation, conflicting emotions about child rearing and their careers, and the pressure to perform even better than men simply to justify their positions, result in some women abandonning science.

Changes in the teaching and practising of science can take place only when women enter the workplace in such numbers that they are no longer perceived to be "non-traditional"

At Bergen Community College, for the spring 1998 semester, 4% of the total female population registered for chemistry and physics courses. For the period 1990-7, only 4% of the matriculated chemistry and physics female students actually graduated.

The use of various teaching techniques to address the different learning styles of students, extra problem solving sessions, extremely well organized lectures that simplify the chemical terminology, mentoring and increased encouragement from faculty, and networking through a science organization are some of the intervention strategies that may lead to the greater success of women in science courses. Increasing success would lead to confidence building and a greater interest for the subject. This will result in fewer women leaving the field.

BEST COPY AVAILABLE

REPRESENTATION OF WOMEN IN SCIENCE

Women make up 51% of the United States population, and an increasing number of them are now working outside of the home. For the period 1996-2006, it is projected that women will constitute 49.6% of all entrants to the labor force. During this period, there will be a growing need for skilled workers and intellectual talent.

Presently, women make up 48% of the employed labor force in the United States. However, women constitute only 22% of all working scientists and engineers. In recent years, women have been receiving close to 50% of all degrees granted. However, the number of them receiving degrees in the physical sciences and engineering, has been much smaller. Male scientists tend to concentrate in the physical sciences and engineering, while their female counterparts tend to concentrate in psychology, and the life and social sciences.

In 1993, women earned 30% of the total number of science and engineering doctorates awarded; 21% of the degrees in the physical sciences, 61% in psychology, 40% in the biological sciences and 9% in engineering. At the master's level, women earned 39% of the awarded science and engineering degrees; 28% of the degrees in the physical sciences, 51% in the biological sciences, 73% in psychology and 15% in engineering. At the bachelor's level in 1993, women earned more than half of the total number of degrees awarded. Of this number, 31% were in science and engineering. The proportions again varied according to the field: 73% of the degrees in psychology, 52% in the biological sciences and 16% in engineering.

For 1996, in chemistry, women earned 43% of the bachelor's degrees, 44% of the master's degrees and 31% of the PhD's. For chemical engineering, women earned 33% of the degrees at the bachelor's level, 23% of the degrees at the master's level and 18% of the degrees at the PhD level.

Since 1991, international scientists have accounted for more than one half of all the mathematics and engineering graduate school students in institutions in the United States. In addition, fully trained international scientists have been immigrating to the United States with permanent visas from Asia and Eastern bloc countries at increasing rates. For example, for 1991 and 1992, they numbered 22,900.

Overall, there has been a decreasing percent of US citizens receiving degrees at all levels in science and engineering and there are concerns that the supply of US-citizen scientists and engineers will not be sufficient to meet the demands of US companies, educational institutions and the government in the near future.

Even though the percentages of women in the science and engineering workforce have been increasing, their numbers still remain low. In 1993, women made up 9% of physicists, 16% of the physical scientists, and 4% of the engineers at the doctorate level, in the scientific workforce.

Two year colleges enroll 46% of the students entering higher education as first year students. They also enroll 50% of the students from underrepresented minority groups entering college.

About 725 of the nation's two year colleges offer engineering and technology classes, and about 500 offer science technology courses. In 1991 and 1992, one third of the total science and engineering graduates at the bachelor's level had also attended community colleges, and about 20% of that group had earned associate degrees. More of the female baccalaurates had attended a community college than men.

BEST COPY AVAILABLE

Women scientists and engineers are more likely to be employed in academia but they represent only 24% of the science and engineering faculty. They are more likely than men to be employed in two year schools, to teach part-time and to have fewer PhD s. They are less likely than men to chair departments or to hold highly ranked positions in colleges and universities

BEST COPY AVAILABLE

THE RATIONALE FOR INCLUDING WOMEN IN SCIENCE

Women have always practised science, but their contributions have been, for the most part, challenged, ignored or marginalized. Women have been excluded from established scientific circles, a practise that is still evident. For example, of the 1634 elected members of the National Academy of Science 70 are women, and only one is a chemist.

Men, having dominated science for so long, have established the rules of the profession, have defined its culture and have determined the way science should be taught. Since women have been excluded from this culture for such a long time, they have had no influence in determining how science is practised, or taught, or how it advances. They have been entering, learning, and working in a system that was created and dominated by men.

Among physical scientists and engineers, gender differences tend to be emphasized because of the low ratio of women to men. This ratio becomes even lower as women advance through their careers. The majority male group tends to stress its dominance of the culture and emphasizes its difference from the "token" women. The minority member is then placed under greater stresses, is under greater pressure to perform, and is usually judged by higher standards of performance. "Token" women are often expected to assume trivial roles which are often exaggerated. These increased stresses often result in their departure from the field.

In the classroom, too, when female students are enrolled in majors like chemistry and physics, in which they are viewed as non-traditional students, they experience pressures that lead to isolation and their dropping out of the major. In fact, female college science students tend to drop their science courses at greater rates than those of their male counterparts even though they may have obtained better grades. In addition, many women perceive the teaching methods used in undergraduate courses as being uncaring and impersonal.

Women and men practise science differently. In their practice of science, men tend to be competitive and domineering, while women appear to prefer a more collaborative approach. More women in the workplace will change the way science is practised and taught. With more diversity, the workplace will become more resilient.

In the physical sciences, women are especially underrepresented in the decision making levels of the profession where they can have a more direct influence over policies that determine the use of technology for use in war, destruction, environmental degradation and the health of their children. To understand and develop policies about the use of technology, women must acquire the necessary science skills.

In recent years, affirmative action policies have been developed to ensure that the best candidate gets the job, even if that candidate is a woman.

Since the population is made up of more women than men, if more women were to study science, an informed scientifically literate society would develop.

BEST COPY AVAILABLE

SOME OBSTACLES FACING WOMEN IN SCIENCE

Many women prefer not to study science or to seek jobs in science because they forsee several obstacles on their way to success. Others will never enter the field because of the negative impressions that they have of the field.

Many women fear that, having graduated from college, landing a prestigious, well paying, scientific job may be difficult, and that the salary may not be as high as their male colleagues. Fears of the "glass ceiling", isolation, and smaller chances of being promoted or being given important projects, may also be deciding factors in abandoning science. In addition, the need for continued education, and the salary compared to the many years of training, may not be as attractive as that of other careers.

The years in which a woman must devote her greatest efforts to a science career coincide with her child bearing years. Many women feel torn between the need to spend the necessary long hours in research, and the need to care for young children.

Some parents and teachers discourage girls from doing science by implying that science is "difficult", that girls are "not good" in science, or that science is a "male thing". In the high schools, many girls, not wishing to appear too smart, deliberately do not push themselves to excel in science.

The media often ridicules scientists, showing them as "mad", and "evil". In general, women in the media are unattractive, unmarried, and are technicians. TV female scientists are always young and never make decisions. This negative portrayal of scientists by the media results in the lack of an attraction for the field by some women.

While men experience an increase in self esteem in college, that of a woman tends to decrease, especially during the sophomore year. The feelings of pressure and isolation arising from being in the minority group may result in despair and loss of self respect. This, as well as a woman's tendency to attribute failure to herself, and success to luck, may cause her to leave the field, despite having achieved some success.

BEST COPY AVAILABLE

SCIENCE AT BERGEN COMMUNITY COLLEGE

In the physical sciences, Bergen Community College offers the Associate in Science degree in chemistry, physics and engineering science. For the chemistry major, general chemistry 1 and 2 and organic chemistry are required. For the physics and engineering options, physics 1, 2 and 3 as well as engineering mechanics are required. The Introduction to Chemistry course for students who have never taken chemistry before, the College Chemistry course for nursing students, and the Basic Biochemistry course for dental hygienists, are all regularly offered. The Introduction to Chemistry, and the Introduction to Physics courses, with their general education designations, are used by many students as their Natural Science elective courses.

In chemistry and physics, there are seven eminently qualified faculty on tenured/tenure track lines; four females and one male in chemistry, and two males in physics. The four tenured faculty have extensive teaching experiences. All seven faculty engage in scholarly work, serve on committees, and some have assumed some administrative duties. New technology has been introduced as the faculty continually revise the curriculum to keep current with the needs of the students and the workplace. The labs are well equipped with state of the art instruments.

For the third semester, the physical sciences faculty, in an effort to increase retention, have been holding extra office hours in a centralized location, to accomodate the needs of any physics or chemistry student enrolled at the school. Recently, extra problem solving sessions have been introduced. In addition, peer tutoring is available at the College's tutoring center.

The College has seen a decrease in enrollment in some areas in recent years. Decreases in the physics and chemistry enrollments are also evident. For spring 1998, a total of 10,942 students enrolled, 2198 full-time and 3738 part-time students. Women enrolled in chemistry account for 4% of all female students enrolled at the College (Table I). For physics, this number drops to 0.9% (Table II).

TABLE I
CHEMISTRY ENROLLMENT, SPRING 1998

Course	Men	Women
Introduction to Chemistry	82	98
College Chemistry	5	12
Gen. Chem 1, lecture	56	46
Gen. Chem 1, lab	49	38
Gen. Chem 2, lecture	35	17
Gen. Chem 2, lab.	28	19
Organic Chemistry	11	8
Total	266	238

BEST COPY AVAILABLE

TABLE II
PHYSICS ENROLLMENT, SPRING 1998

Course	men	Women
Intro. to Physics	46	25
Gen. Physics 1	10	2
Gen. Physics 2	3	11
Physics 1	16	4
Physics 2	18	5
Engineering Mechanics	9	3
Total	102	51

In chemistry, for the penod 1990-7, of the 154 men and 88 women that were matnculated, 9 men and 3 women actually graduated. Over this penod, the number of matnculated male students had doubled, while the number of women had tnpled (Table III).

TABLE Iii
MATRICULATION AND GRADUATION DATA FOR CHEMISTRY
1990-1997

Chemistry Enrollment
Fall 1990-Fall 1997

Fall	Male	Female	Total
1990	11	7	18
1991	10	4	14
1992	19	5	24
1993	17	4	21
Fall	27	13	40
1995	24	17	41
1996	27	18	45
1997	19	20	39
Total	154	88	242

Chemistry Graduates
Fall 1990-Fall 1997

Graduate	Male	Female	Total
1990	1	0	1
1991	1	0	1
1992	1	1	2
1993	0	0	0
1994	1	0	1
1995	1	0	1
1996	2	2	4
1997	2	0	2
Total	9	3	12

BEST COPY AVAILABLE

In physics, for the period 1990-7, 45 men and 9 women had matriculated. Of these students, 3 men and 1 woman graduated. Over this eight year period, the number of matriculated men increased by a factor of five, while there was no matriculated female since 1993 (Table IV)

TABLE IV
MATRICULATION AND GRADUATION DATA FOR PHYSICS
1990-1997

Physics Enrollment
Fall 1990-Fall 1997

Fall	Male	Female	Total
1990	2	2	4
1991	3	4	7
1992	9	2	11
1993	6	1	7
1994	4	0	4
1995	5	0	5
1996	6	0	6
1997	10	0	10
Total	45	9	54

Physics Graduates
1990-1997

Graduate	Male	Female	Total
1990	1	0	1
1991	1	0	1
1992	1	0	1
1993	0	1	1
1994	0	0	0
1995	0	0	0
1996	0	0	0
1997	0	0	0
Total	3	1	4

Sixty two (62) women enrolled in the general chemistry and physics courses, in organic chemistry, in the physics 1, 2 and 3 and engineering mechanics courses, participated in a science survey during February, 1998. Students were asked to list other science courses that they had taken, to indicate their major and to identify some reasons for choosing or avoiding science. Students were also asked to comment on their high school experiences, and the support they received from their families and friends. Students were also asked to suggest some ways for the improvement of teaching that would make science less formidable.

Of the women surveyed, 92% had taken other science courses, but only 55% had decided to choose a science major. Of the 55%, 65% were planning to continue in science, 15% in chemistry, 12% in engineering and 73% in the biological sciences. Thirty two percent (32%) of the biology majors planned to attend medical school. The women who did not choose a science major were fulfilling science requirements for their majors, predominantly in the health science field. The science majors chose

BEST COPY AVAILABLE

science because of their own interest and fascination with the subject and because they had experienced some success in previous science courses. Those who did not choose science reported fewer successes in these courses which they perceived to be long and difficult.

In high school, 63% of the respondents had positive experiences based on their success in science courses, support and encouragement from teachers, and their own interest. The other 37% of women thought that poor grades, difficult classes, inability to cope with the mathematics aspect of the courses,and the lack of any encouragement to study science, as factors in their decisions not to pursue science careers.

In their comments about teaching methods, most of the women preferred the very organized lecture format, with detailed explanations and the use of visual aids. More problem solving, group work, real life applications, the explanation of scientific terms in any easy to follow manner, and more student-teacher interraction in the classroom, were perceived by them as factors that would contribute to their greater success.

More women, 74%, described supporting and collaborative relationships with other women in the classroom. However, 34% of the women experienced disrespect and other negative reactions in their relationships with the male students in the classroom.

Positive reactions and support for their dedication to science, were received from family, friends and spouses by 77% of the respondents. Fewer women, 47%, felt that they had received the same encouragement from their professors at the College.

Only 27% of the women surveyed thought that they would experience discrimination in landing a job in science. More women, 47%, felt that they would experience discrimination on the job in terms of salaries and opportunities, and by not being taken seriously.

Almost all of the women saw a correlation between the science they were studying and real life, and were interested in learning more about the contributions made by women to science.

BEST COPY AVAILABLE

RETENTION STRATEGIES FOR WOMEN IN SCIENCE AT BERGEN COMMUNITY COLLEGE

Only a small number of the total number of women enrolled at Bergen Community College register for chemistry and physics courses. An even smaller number of these women plan to major in science. A classroom atmosphere that is female friendly, a curriculum that includes women and their various learning styles, and mentoring by faculty, will all result in the development of many women's enthusiasm for science. Their interest for the subject and the confidence that they can succeed in science, would result in many more women remaining in the field, long after leaving the College. In addition, more women would be attracted to the science programs at Bergen Community College, as anecdotes of the positive experiences that other women have enjoyed, are described to family and friends. It should be also emphasized that any well evaluated programs that effect changes in the curriculum or in teaching strategies will benefit all students.

CURRICULA AND THE CLASSROOM

1. Develop curricula that will acknowledge the contributions of all scientists, both male and female of diverse racial/ethnic backgrounds and cultures. Include the names of women scientists who have made important discoveries. Emphasize that many ordinary scientists make valuable contributions to the discipline, but do not achieve fame, or win prestigious prizes. Some women feel inadequate in becoming scientists when confronted with role models of only famous scientists. Many women, both at the graduate and undergraduate level work in the laboratories of Nobel Laureates and contribute to the work that brings the mentor the recognition. The examples used should relate to the broader audience as well.

2. Use a range of teaching methods to accomodate students with different learning styles. For example, demonstrations, molecular models, videos, computer simulations and multimedia, collaborative exercises, journal writing, writing out their thought processes as they solve a problem, and library projects may be used.

3. Encourage women to work with each other especially when working with lab equipment or computers. In male-female partnerships, frequently, the male works with the equipment while the female writes down the observations. She therefore gains no experience with the equipment and becomes inadequately prepared for her next science course. Women tend to adopt a more collaborative approach to problem solving. In group work, do not assign only one woman to each group since being considered as the "other" often results in the woman not participating to the fullest extent.

4. Include chemistry and physics courses in the Honors program and encourage more women to enroll for these courses.

5. Consider the woman's point of view just as seriously as the man's. Incorporate her personal experiences as a part of class discussions to introduce new perspectives on old issues.

6. Do not tolerate the use of sexist language in the classroom.

7. Encourage women to be more assertive, and to ask more questions. Engage them in more discussions.

8. Recognize that older returning women tend to feel isolated both from the younger students, and from the faculty to whom they may be closer in age. Encourage more interraction with this group.

BEST COPY AVAILABLE

9 Use introductory courses to recruit rather than to weed out women

10 Women are more likely to understand and be interested in solving problems that do not involve guns or violence because they are perturbed by the ways science has been used against the environment and humans. Instead, discuss the practical uses for which scientific discoveries have been used to improve people's lives, for example, the use of chemistry for synthesis of [illegible] The relationship of science to other disciplines should be also mentioned, for example, the importance of chemistry to microbiology

11 Recognize that the language of chemistry is unique and explain the meaning of the chemical terms in the simplest possible manner

12 Educational goals that stress ethics, general education, and communication skills are more important to women than to men. Accomplish this by including journal writing or library research projects

13 Emphasize some of the positive aspects of studying science at Bergen Community College. Small classes result in more individualized attention. Professors teach both lecture and lab classes. Role models can be found in the faculty who have balanced a career and marriage, and in some cases, families. The faculty are all enthusiastic about their chemistry, are available, approachable, easy to talk to, patient, and are willing to spend their time with students

B. MENTORING

1 Most people who have succeeded in science have had mentors. A mentoring program should be started to help students achieve self confidence, academic success and their personal goals. A successful program will result only if all faculty, counselors and administrators are committed to providing students with a meaningful learning experience

2 A science club, a women's center, or a local chapter of the Association for Women in Science would provide support and networking opportunities. Topics and issues critical to women's professional development can be addressed. Options to women who never considered science may be introduced through role models, speakers, and career development workshops. A big sister program can be started in which upper level students can share their experiences of courses and instructors with lower level students. Travel awards, if possible, may be provided to attend conferences, where students can network, share information, and develop employment contacts

3 Encourage women to use electronic communication to establish and maintain contact with their professors and other women, to reduce feelings of isolation

4 Mentors should address issues of marriage and family as they relate to career choices and the concerns of young women. Discuss some strategies for coping. Mention that women in science do not have to confine themselves to a lab, but may enter one of the numerous science related fields such as information science or scientific consulting

5 Emphasize that science is 75% ambition and 25% ability. With dedication and hard work, women can succeed in science

6 Many students leave science during the early college years when they have to decide on a possible major. Monitor their progress through interviews or surveys so that the appropriate intervention strategy may be applied

BEST COPY AVAILABLE

7 Women, fearing that they would break the expensive lab equipment, often show hesitation in using it. Instructors should spend more time helping those students who are not confident with the manipulation of the equipment.

8 All faculty, both male and female, should develop, evaluate, and revise strategies for attracting and retaining women in science.

9 Stress the fact that the public attitude and that of the media would change only as more women understand science and begin to demand changes.

10 Emphasize that scientists are not all the same. Women can excel in science and still be very feminine.

C TUTORING

1 Encourage women to seek help from their professors and from the tutoring center. Small study groups to complete homework, and to study for exams have been found to be very useful.

2 The College should establish a physical sciences learning center where students can be tutored, and where they can engage in self tutoring using computer programs.

D OTHER

1 More women should be encouraged to apply for financial aid. Scholarship sources, grants and summer internships that target women in science should be researched and announced to all women. Faculty should also inform students of any job opportunities of which they are aware, and support the students' applications with recommendation letters.

2 The top level administrators at the College, who are not science majors, should be alerted to the special problems encountered by women in science.

3 Special projects outlining the contribution that women have made to science should be undertaken, for example, during Women's History Month.

BEST COPY AVAILABLE

BIBLIOGRAPHY

1 *Bureau of Labor Statistics*. Feb. 1998

2 National Science Foundation, *Women, Minorities and Persons with Disabilities in Science and Engineering*. 1996, Arlington, WA, 1996, (NSF96-311)

3 *Office of Research and Planning*, Bergen Community College. 1998

4 ACS Committee on Professional Training 1996 Annual Report. *Chemical and Engineering News* 76(5), 35-42, 1998

5 *Women Changing Science*, Mary Morse, Insight Books, NY. 1995

6 *Science and Engineering Programs, On Target for Women?* National Research Council, National Academy Press, Washington, D.C., 1992

7 *Who Succeeds in Science*, Gerhard Sonnert, Rutgers University Press, NJ, 1995

8 *A Hand Up: Women Mentoring Women*. The Association for Women in Science. Washington, D.C., 1993

9 *Teaching the Majority: Science, Mathematics and Engineering Teaching that Attracts Women*, Sue Rosser, Teachers College Press, Columbia University, NY. 1995

BEST COPY AVAILABLE